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ABSTRACT

An exposition is made of a method to elicit students' comprehension of the meaning of words commonly used in science, which may be influential in determining what they learn. The method's aim is to elucidate features in students' understanding of childrens' science (that found before formal teaching of science), student science (that found after formal teaching of science) and scientists' science (the consensus found among the community of scientists). The Interviewing-About-Instances Technique, which invites the subject to classify examples depicted as line drawings on cards, as instances or non-instances of a word, e.g. work, electric current, force, living, and to explain the reasons for each classification, is outlined. Guidelines for the planning of such a method and the designing of materials are given. The interview technique is based on a non-evaluative researcher orientation and seeks an elaborative reflective approach which seeks flexibility in use across age groups, in allowing reference back to earlier discussion, and in the analysis of unexpected comments. Techniques for the transcription, condensation and analysis of data, and for checking the representativeness of data are described. Also presented are outcomes of using the technique, illustrated by examples. (Author/AEF)

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ELICITING STUDENT VIEWS USING AN INTERVIEW-ABOUT-INSTANCES TECHNIQUE

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SUMMARY

It is argued that the meanings for words which students bring with them to classrooms are very influential in determining what is learnt there. A detailed exposition is made of a method for eliciting these meanings, called the Interview-about-Instances technique. Some outcomes of using the technique, illustrated with examples, are presented. Projections are made of the future applications of the technique.

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Introduction

The realization that students bring meanings for words, which are commonly used in science, to the science classroom is of longstanding. One view of their consequences for teaching has also been established e.g. Ausubel (1968) refers to 'preconceptions (that are) amazingly tenacious and resistant to extinction'. This implies that such views are, in some essential way, not only 'wrong' but 'bad'. However, another interpretation is emerging. Driver and Easley (1978), referring to them as 'alternative interpretations', observe that "In learning about the physical world, alternative interpretations seem to be the product of pupils' imaginative efforts to explain events and abstract communalities they see between them". Whatever response teacher decide to make to them, such meanings are a genuine part of children's culture.

If a meaning is held before the word is met in formal science classes, we would refer to it as being part of 'Children's science' (Osborne, 1980). Across a population, a range of meanings would exist for a particular word. Every child would employ a range of words, the sum of which would constitute a large part of the individuals 'children's science' (S_{Ch}). That meaning for a word which was held by a consensus of the scientific community we would describe as being part of 'scientist's science' (S_S). That version of 'scientist's science' which is selected by curriculum planners for inclusion in a syllabus or is enshrined in a textbook, could be called 'curricular science' (S_{CR}). The interaction between 'curricular science' and a teacher produces 'teachers science' (S_T). In classrooms, 'children's science' and 'teachers' science' interact to produce 'students' science' (S_{ST}). These representations of knowledge can be articulated (Zylbersztajn (1980)) into the following sequence.

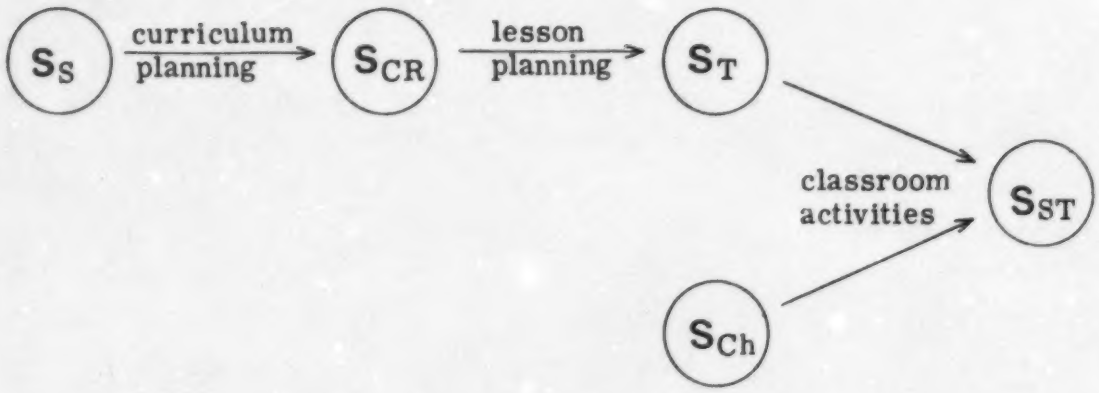
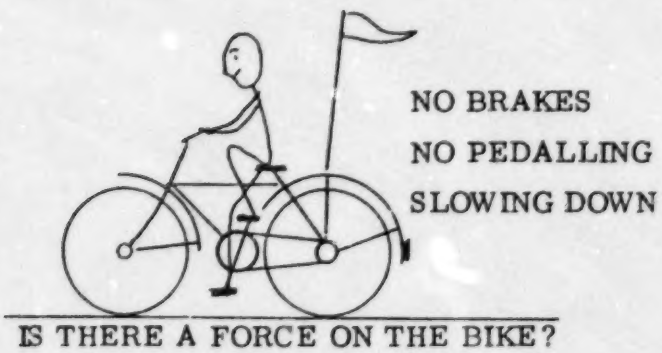


Fig I Transformation of scientific knowledge.

If 'children's science' is a major feature in the curricular landscape, then attempts to elucidate its characteristics seem called for. Investigators seeing their task as the measurement of the extent to which students have learnt the correct, or 'scientist's science' version of a word meaning, will use 'comparative' methods e.g. multiple-choice questions, open response questions. At the opposite end of the scale, investigators taking an ethnographic, or non-comparative, approach will wish to examine the use of words in 'realworld' settings. The most usual and complex of such settings is the normal school classroom: both Tasker (1980) and Zylbersztajn (1981) are conducting such studies. The 'simplified classroom' i.e. one where two or three students are given lesson tasks to perform in a separate room has also been used e.g. by Tiberghien (1980) . The 'middle ground' between these extremes ie methodologies capable of adaptation to a 'comparative' or 'non-comparative' mode, seems potentially fruitful. Certainly, open response questions can be used in this way e.g. Viennot (1979) as can a modified multiple-choice approach e.g. Helm (1980). It is into this middle ground that we have introduced the Interview-about-Instances (I.A.I.) technique (Osborne & Gilbert (1980) Gilbert & Osborne (1980a)).

In outline, the I.A.I. technique consists of tape-recorded dyadic discussions with a student, using a deck of cards, concerned with the applications of one word, as a focus. A card consists of a line-drawing of a situation which may, or may not, represent an example of the application of the word. Whatever the student's response, reasons are sought. The method can be used over a wide age range, as an example will show. Take, as an illustration, the card about 'cycling' from a deck on 'Force'.



Typical answers are all related to one particular viewpoint:

"Yes...the wheels are still going so that there would be a force from that".

(aged 9)

"It is just putting force on by itself...from the force you gave it before".

(aged 11)

"Yes...the speed that he (sic) has already got up"

(aged 19, Teachers College student who passed U.K. 'O' Level in Physics at 16)

"There is a force because of the bike's own mass... the mass of the bike has come (to) such a speed that it won't just stop straight away...the force is still in there...in the bike...the force was transferred from the person pedalling and it is now still adherant in the bike...the bike still moves forward"

(aged 20, Teachers College student who passed U.K. 'A' Level in Physics at 18)

A deck of such cards, perhaps 15 in number, will reveal the breadth, and manner of use of the chosen word over a range of situations.

Two of us (J.K.G. and R.J.O.) initially evolved the I.A.I. technique while working together at Surrey in 1978/79. Since that time the two research groups at Surrey and Waikato have been working on the development of different aspects of the technique. At Surrey particular consideration has been given to establishing the 'ground rules' for designing sets of cards and developing a systematic methodology for handling the transcription of data. At Waikato emphasis has been placed on using the method with a wide variety of words and interviewees, and in exploring how findings from such studies can be condensed and described to teachers and curriculum developers in a way that they find useful and which will have impact on teaching in schools. These various aspects of our recent work will now be described.

Designing a deck of I.A.I. cards

The initial design of a deck of I.A.I. cards may be undertaken by following the algorithm presented below (Watts, D.M. (1980a,b,c)) The algorithm is exemplified by considering the design of a set of cards to investigate the word 'force'.

1 Identify the 'scientist's science' meaning of the word. For 'force', three component viewpoints can be isolated i.e. "force as 'pushes' and pulls'", "resultant force equals mass x acceleration", "forces are interactions of nature". Combined and extended, these produce "a force results from interactions between bodies capable of changing the velocity size or shape of the bodies".

2 Analyse the 'scientist's science' view.
This implies an exploration of the 'accepted' meaning of 'body', 'interaction', 'changing velocity'. It also involves analysing the view for its 'vagueness' and 'ambiguity' after the manner of Quine (1960) and Lachenmeyer (1971).
The 'vagueness' of a view is a measure of the extent to which the range of object predicates which form its referential meaning have been specified i.e. the distance between its connotative meaning and its denotative meaning. For 'force' the level of vagueness is acceptably low: its meaning rests partly on that of interaction'which can be specified in one of four distinctive modes i.e. 'strong', 'weak', electro-magnetic' and 'gravitational'. The 'ambiguity' of a view measures the extent to which it has multiple, equally legitimate meanings. In a ''physics' context the ambiguity of 'force' is low but for its 'societal' meaning the value can be said to be higher e.g. 'a person was forced to agree with another', 'a person was forced to do what another person wished'.

It also involves clarifying the distinction between 'basic quantities' and 'derived quantities', the latter being derived from and defined by the former. However, the base which is chosen is usually a matter of convenience. This analysis recognises the convenience of defining 'force' in terms of 'mass' and 'changing velocity'.

3 Identify the 'criterial attributes' of the word in S_s. These are the essential qualities, all of which must be recognised if the word is to be used in a way acceptable to scientists. For 'force', these involve specifying:

(a) its magnitude and direction
(b) the body on which it acts
(c) the body that exerts the force
(d) the nature of the force i.e. the type of interaction occurring.
(e) the effects of the force e.g. changes of direction, size, shape.

4 Identify the 'non-criterial attributes' of the word in S_s.

These are statements about situations, or circumstances, which are sometimes made and which involve the word in some way e.g. for 'force'.

(a) the weight of an object can be said to act through its centre of gravity.

(b) tension is the condition of a body subjected to equal but opposite forces which may lead to an increase in linear dimensions.

(c) forces can be measured in 'newtons'.

(d) 'surface tensions' can be accounted for in terms of inter-molecular forces.

The number of such statements are usually great (around 30 for 'force', at school level), the range being decided by consultation with curricular materials.

5 Identify sources of obvious linguistic confusion.

These may be grouped into one of three types: antonyms, synonyms, homomyms. The antonyms for 'force' are 'weakness', 'incapacity', 'enfeeblement', 'tameness'. The synonyms for 'force' are 'strength', 'power', 'impetus', 'violence', 'intense', 'effort', 'military might', 'body of people', 'drive', 'population', 'validity'. Homonyms for 'force' are 'fours' (quadrupled), 'fauces' (a cavity of the mouth) and 'faucet' (a tap). Any of these might conceivably enter into a potential student answer: cards should be designed with these possibilities in mind.

6 Identify sources of invalid use of the 'scientist's science' meaning.

The first, and probably major, source is that pool which can be called 'common usage' meanings. These are inevitably numerous: for 'force' examples are 'force of habit', 'force of law', 'forced labour', 'forced march'.

A second group is that which may be termed 'misuse of the scientist's science meaning. Warren (1979) has identified a collection of misuses for 'force' i.e.

(i) the inclusion of force where non exist, to account for effects noted in a situation.

(ii) the omission of vector components

(iii) an inadequate description of the bodies exerting the forces on the situations in which the interactions are taking place.

If 'examples' of a word may be defined as instances where it could be accurately applied, in the S_s meaning, then non-examples' may be defined as instances where it cannot be so applied. For 'force', instances which were non-examples might be those where it was not possible to specify the

(i) forces acting

(ii) the nature of the forces

(iii) the magnitude of the force

(iv) the direction of the forces

i.e. where one or more of the criterial attributes could not be identified.

7 Producing cards.

Parts 1 - 6 in this sequence, which have already been discussed above, might be designated as an exploration of potential sources of alternative conceptions. The actual production of cards is a mixture of art and science. What is required is a mixture of 'examples' and 'non-examples'. Each example would represent all the Criterial Attributes and some of the Non-criterial Attributes: for a deck of cards the intention would be to include most or all of the Non-criterial Attributes. Each non-example would have one or more of the Criterial Attributes absent, yet include some of the non-criterial Attributes: over a deck of cards the whole spectrum of combinations of Criterial Attributes would be omitted, and all the non-criterial Attributes included.

That said, the design of individual cards will depend on the insight of the researcher. The over-riding concern must be to have cards which simultaneously allow S_s, S_{Ch}, S_{ST} to be demonstrated. Thus they must be interesting to the interviewees: ideas can be sought from the illustrations in textbooks, from TV and by the simple expedient of asking students and teachers for 'challenging situations'.

8 Ordering cards into a deck.

For interviews, with students who are shown to have adopted the S_s view, it has been found that the optimum deck contains fewer than 20 cards: with younger and less 'knowledgeable' interviewees the activity is appropriately truncated in the light of the following sequence.

(a) Cards 1 - 8 : 'examples' } not necessarily used in
(b) Cards 9 -12 : 'non-examples' } this order

(c) At this point the interviewee is asked for and explanation or definition of the word in his/her own words.

(d) Cards 13 - More difficult instances, likely to be novel to the interviewee, looking like 'textbook physics', and including 'borderline' examples. However, the final identification of cards and their ordering into a sequence is an interactive process forming part of the investigation design.

The Process of elicitation

The sequence of events in which the elicitation takes place may be summarised as below:

(a) design a deck of cards (see above)

(b) conduct a series of pilot interviews e.g. with about 5 - 10 students covering the age range to be investigated, to remove anomalies in design, wording and sequencing.

(c) Conduct 15 - 20 interviews, making fully detailed transcriptions. An inspection of these will show whether individual cards, and the sequence adopted, best facilitates the presentation of student's own interpretation. This will lead to a final review of the deck.

(d) Conduct the investigation proper.

The choice of a sample of students, with whom to conduct interviews, is an initial challenge. The I.A.I. approach may be seen to be within the framework of 'case studies'. The problem is: what is the case? If the case is an individual student, who will perhaps be interviewed about a number of words, then any articulate individual is satisfactory.

If the case is the whole of a naturally occuring group e.g. a class, then no problem is encountered for all are interviewed. However, if a selection is to be made from a class, then its basis needs careful consideration. As Pines (1980) has pointed out, interview techniques work best with articulate students and these may not be cognitively representative. If the teacher is asked to select a number of 'about average' students to be interviewed, then the 'articulation factor' is compounded by the natural desire to 'please' the researcher by providing a 'satisfactory' student: this often means a 'good one'. The use of auxiliary tests to select students e.g. Piagetian tests, verbal reasoning tests, seems equally problematic because the relation between scores on these,and 'Children's science', is unclear.

Interviews are best conducted on complete privacy, for only then will the participants relax (provided that neither feels threatened). The amount of extraneous noise on a tape-recording will also be reduced to a minimum. The participants sit side-by-side whilst the interviewer sets the scene for the interview. We have found it useful to say something like 'You will know from your own experience how teachers sometimes use words in classes which do not agree with your understanding of those words. I want to find out how you use a particular word...there are no right answers or wrong answers... so that we can get teachers to see your point of view' is found universally acceptable. The interviewer then asks permission to record the discussion 'because I can't concentrate on what you are saying and take notes': again this is almost always acceptable.

For the interview does take the form of a discussion. From the initial fairly-openended question e.g. "is there a force here?", the purpose of the interviewer is to identify, as accurately as possible, the student's perceptions.

Thus all interviewer response is non-evaluative, supplemental questions being asked until the interviewer has fully grasped the student's ideas. Many of the skills needed e.g. the reflective quotation, are standard in the area of counselling. Thus the deck of cards is proceeded through, reference back to earlier cards being made either at the student's behest, to change an earlier response, or by the interviewer, if there is a glaring discrepancy in the answers given to two cards. At the end of the sequence, or whenever the interviewer has decided that further progress is unlikely, the student is offered an opportunity to revisit any of the cards. By this time the student is usually still relaxed but a little tired: the interviewer's final questions (although they can be placed at the beginning) concern the students prior academic achievements, age, class, previous experience of science teaching and interest in physics. At no point is the student given any evaluation of 'success or failure' .

The transcription of interviews

The transcriber faces a number of challenges in this vital task:

(i) Talk is discontinuous, being punctuated by gestures, faltering, pausing, showing various qualities of voice, and is delivered with a variety of facial expressions and in many body postures.

(ii) The sequence of a conversation is difficult to follow, being full of inconsequence, confusion, pauses and contradictions.

(iii) The tape recorder, whilst ignored for the majority of an interview, can occasionally become the focus of the student's attention.

In short, it is inevitable that a transcript is a translation prepared by the transcriber. Whilst the interviewer will have made notes on some of these features, which should be immediately related to a transcription prepared very shortly after an interview, the transcriber will need to use some precise conventions. Of these, the two most important concern the style and notation of the transcript. In style, we have found it convenient not to punctuate the transcript, nor to divide the speech into sentences and to omit fullstops, commas and the like. The question mark is also omitted, for the verbal inflective associated with questioning is sometimes used to make statements, the truth of which is uncertain to the speaker. Pauses are typed and marked, noises e.g. laughter, included. The transcription is prepared with wide margins (for subsequent annotation) and marked with 'revolution-counter' numbers from the tape recorder. The transcription is best done in two distinct phases. First of all, the words and noises are presented verbatim. Then the tape is replayed, entering intonations, pauses and comments. Irrespective of who does the first part, it must be checked by the interviewer and the latter must undertake the second part.

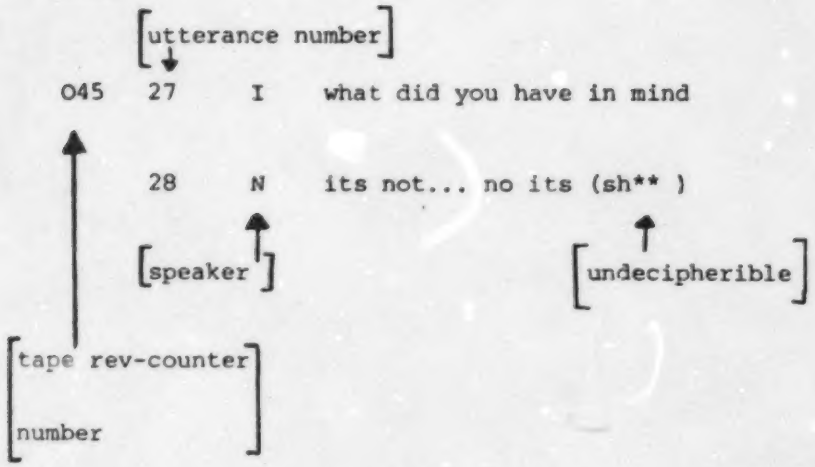
The notation that we use is as follows:

(a) Square brackets [ ] enclose information and comments on the right hand side of the page.

(b) Round brackets ( ) enclose interpretations, where unavoidable, after the utterance to which they apply.

(c) Transcriber's doubt (*), shown by asterisks in round brackets with as much of the sound included as possible. The number of asterisks indicate the number of words.

eg 1



d) A pause . full stops are used to indicate a pause. One stop is used for a very short pause, thereafter the number of dots reflect the length of pause.

e) long pauses .. 8 .. These are indicated by the number of seconds shown as a figure.

eg 2

053 32. N its a . er ... force of some sort ..5.. I think

f) prolonged sound : : A drawn out word is shown by including a number of colons in the word.

eg 3

064 46 I yes if someone tries .... well .. fo::rce you to do it

g) stressed syllables _ this is best done by underlining.

eg 4

066 48 N oh but no thats different .... power is not the same thing at all

h) overlapping [. A single square bracket indicated overlapping utterances or where a second speaker cuts into another.

eg 5

102	63	I	did you	.....	[I mean
		N			[yes it was easy to keep doing it

and eg 6

121	76	N	and the force is this		[way and
	77	I			[I see
	78	N	not the way it seems here		

i) Rising tone / . This marks a rising inflection, not necessarily a question.

j) Falling tone \ . A falling inflection.

k) Exclamation mark ! Used at the end of an utterance considered to have exclamatory intention.

l) Umms and ers are included as appropriate. A whistle or a sigh - the sort you might let out at the end of a hard days digging in the garden (whew!) - these are included as whhhh.

m) laughter, a snort, or cough , etc. is included as (laugh) (snort) (cough) (etc.)

The Analysis of a transcript

The first task of the editor (usually the interviewer) is to impose a structure on the transcript by identifying and separating the discreet utterances made i.e. when a piece of meaning starts and ends.

We have identified five categories in these 'meaning units', which are concerned with types of talk and function in the interview. These are

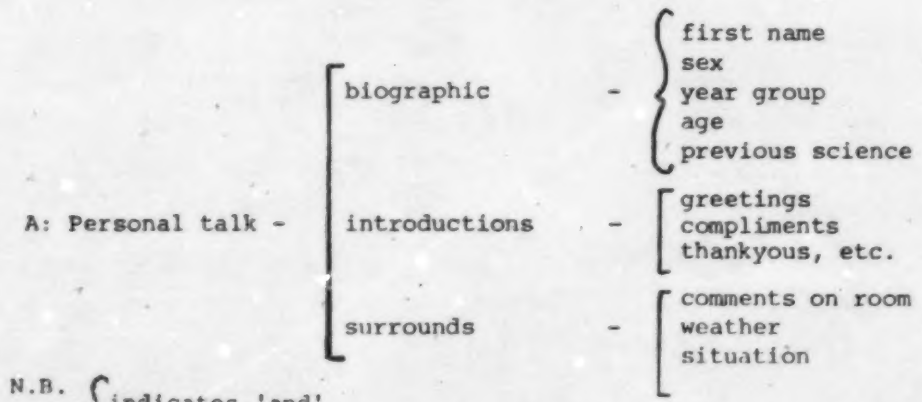
A PERSONAL
B TASK
C CARD
D CONCEPT
E FRAMEWORK

These are elaborated below.

A 'PERSONAL'

This is all the dialogue that takes place relating the individuals in the interview. It is the greetings, introductions, "what courses are you doing?", "what do you want to do when you leave school?" It is the institutional, social talk that starts and ends the meeting. The function of the talk is the necessary softening of approaches and opening of communication channels. The function of the category is as a collection of dialogue that doesn't fall into the other boxes. Its useful, too, for providing the holistic overview to the whole interview. Both the 'Personal' and 'Task' categories are necessary if all the data is to be accounted for.

In network terms it can be abbreviated to:



B 'TASK'

In this next phase, the talk concerns the task, what to do, the confidentiality of the tape, the 'survey-nature', the topic of the cards, etc. This occurs throughout the interview. The function of the talk is to establish the role-play of the task, and cement the 'contract' of the interview. The success of the mission, the stragegies the student's adopt , etc. will depend on this part of the session. The function of the category is, again, as a fairly loose framework for small talk.

C 'CARD'

It is easier to describe the function of this category before describing the type of talk it involves.

When a youngster is faced with one of the cards, the concentration fluctuates between 'what is happening in the card', to 'what happens generally', and then to the wider scheme of things. We wish to be able to separate 'local' effects from underlying 'articles of faith' from the students 'macroplan'. This category we call 'card' and it relates all the talk that we think is a local effect i.e. an immediate response to details or aspects of one card.

These particular, context-specific responses have another function. They carry all the evidence for the next category (D : the 'concepts'). They bear all the hallmarks of the 'articles of faith' i.e. the usually implicit rather than explicit 'alternative conceptions'. For example, we quote Jonathan, 14 - 15 year old 'expected to get a good grade in physics next year'). The card concerns a golfer hitting a ball: the 'card' category responses have been underlined.

129 115 J there'll be quite a few forces acting on that ball

116 I yea what are [they

116.5J [they're the thrust of the heating drag of the resistance ....yes....there'll be gravity pushing it down and.....when it hits the ground there will be momentum keeping it going and it will be leaving far more fric by far more kinetic energy by friction because its going through the air because the air is much much more er.....less dense than the ground its.....so what few forces acting on [there

117 I [tell me about the thrust one you haven't you didn't mention that one before [what's the

118 J [thrust is because the push is the actual thing powering it which in fact could be the club making it go so the power is transferred from club to ball and then lost in the ground

He starts with 115 "there'll be quite a few forces acting on that ball". This is a meaning unit i.e. the student seems to have communicated a particular piece of understanding. It is card specific. It means that he has signalled that the card represents his idea of forces. Secondly, he has singled out the ball, not the golfer.

After I 116 "what are they?" he gives "...they're the thrust of the heating drag of the resistance..."

That in itself is another meaning unit. It is also card specific, in that he doesn't refer to this topic again in the interview.

D THE 'CONCEPT' BOX

This is two kinds of talk. It is explicit talk that generalises between cards; defines forces; gives examples; makes statements about a concept of 'force' etc., etc. It is also a combination of the implicit hallmarks, that indicate a particular conception. For example: an implicit statement lies back in Jonathan's utterance 118.

The Aristotelian view of forces means the golf ball needs a a 'driving force' to get it through the air. Jonathan is a basic Aristotelian. When asked about 'thrust' (117) he moves quickly from thrust to power, via powering. That whole four lines is a meaning unit that says: the ball needs a 'driving force' for 'making it go'. This is a part of specific card talk but heralds the 'force/motion' conception. It reappears in two more cards and so it is something general to the cards.

The meaning unit has at least two functions. It labels some aspect of a card or situation. It also holds a meaning potential - it might be a harbinger of a particular alternative conception. This can best be decided if there are more than one to reinforce a particular view.

E THE 'FRAMEWORK'

This is the 'macro-plan'. Children may have specific answers to specific cards ('card' talk), they may have starting points for arguments ('concept' talk) - they also include a wide range of ideas from outside the cards to substantiate their conceptions. This is 'framework' talk. For example, Jonathan has an extensive framework. He incorporates 'less dense air', 'power', 'resistance', 'thrust', 'drag', etc. with some semblance of meaning into his explanations.

It is this web of ideas, the 'causes' and 'effects' of forces, that form the wider macroplan of the pupil.

This category has two functions. Firstly, it includes all this kind of talk that expands conceptual framework of ideas. Secondly, it collects all the talk that is projections, speculations or consequences of the situation depicted in the cards.

In this Conference Paper we can do no more than provide a taste of the complexities of data analysis. Indeed, one major problem in this type of work is to provide a suitable platform for its detailed discussion.

The Representativeness of data obtained

In case-study work, particularly that concerned with the representation of cognition, parallels to the notions of reliability and validity, taken from the psychometric tradition of research, are difficult to draw. Test-retest reliability seems unlikely to be applicable, for the mere process of being interviewed about a word seems, after some reflection, to itself cause a revision of the understanding held. Parallel-form reliability seems more operable, in that it should be possible to design parallel versions of the same I.A.I. card deck. However, the problem of separating two 'identical' groups of students seems intracticable. Face validity seems assured by the group nature of the preparation of card decks. Concurrent validity has not yet been explored : however, work is underway to compare the utility of the I.A.I. technique with the Kelly Repertory Grid technique.

Construct validity has been investigated for demonstration-type interviews (e.g. Archenhold (1980)) in respect of Piagetian stages. The significance of these results must remain unclear whilst the mechanisms for the development of both word understanding and Piagetian stage promotion are uncertain.

In the meantime, it is only possible to check, using survey techniques, to see if the patterns of student understanding identified by interview means are replicated over large sample sizes. For example, interviews, both in the U.K. and New Zealand, investigating 'force' suggested that it was very common for children to associate 'force with movement', as exemplified in the first section of this paper. Zylberstajn and Watts (1980) used a combined multiple-choice/explanation format to investigate the prevalence of this view (see Appendix A). A modified version of this survey, omitting alternatives (d) and (e) was used in New Zealand and yielded the results given in Appendix A.

Results obtained by the I.A.I. method and the communication of these results to others

The I.A.I. method has been used for over 600 individual interviews in England, New Zealand and Australia. The most extensive use of the method has been made in the Learning in Science Project (Tasker, et.al., 1980) where children's meanings of the words 'force', 'friction', 'gravity', 'energy', 'light', 'particles', 'electric current', 'animals', 'plants', 'living', and 'weather', have been explored (for example, see Osborne, Gilbert (1980); Stead, Osborne (1980)). In each study some 40-50 children, ranging in age from 9-18 years have been interviewed. While some of this work has uncovered children's views similar to those uncovered by other workers using other methods (e.g. Piaget and Delacote in France) other views were unanticipated. For example, to many children friction between surfaces can only occur if the two surfaces are in relative motion.

As West (1980) points out, work on children's cognitive structures is not only influenced by the model of cognitive structure which the researchers hold[1] and the method of eliciting information, but also the

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[1] We are primarily concerned in this respect with an individual's existing concepts (or modes of approach to sensory information), of the boundaries an individual has devised for himself or herself between the various concepts, and the way children associate words with these various concepts. In our view, a concept is a 'disposition to act' and hence it has both 'affective' and 'cognitive' components.

purpose of the work. Within the context of the Learning in Science Project the work is primarily concerned with providing teachers and curriculum developers with information about children's meanings for the words investigated. In this regard, West's comment about combining information is particularly pertinent (West, 1980, p. 348)

> "There are now a range of methods for eliciting information from students about their cognitive structures. The difficult task that we all face is to find a method of data reduction, of summarizing the mass of information in a manner which does not distort it, and in combining information from more than one student in a manner that is meaningful and useful"

The approach adopted within the Learning in Science Project to this problem has been to 'condense down' each child's original transcript, taking care not to distort the child's responses in terms of the underlying scientific or non-scientific idea. Usually similar responses by different students to a particular instance or non-instance have been grouped together allowing further reduction in the amount of data. Working papers (LISP, 1980) have then been written, describing the views held by those interviewed, for each word investigated. In these papers children's views with respect to each interview card, have been exemplified by quotations. These quotations have been annotated in each case with the code numbers of all the other interviewees who held a similar viewpoint. A genuine attempt has been made in writing these papers to provide examples of <u>all</u> predominant views contained within the responses of those interviewed, and to give information about the prevalence of the various views held by those interviewed. In some cases, where considered appropriate, surveys have been devised to gauge the wider prevalence of certain views at various age levels using statistically representative samples. The results of such surveys have been incorporated into the working papers. An extract from a typical working paper is provided in Appendix B.

The working papers have been distributed to small groups of teachers firstly to enable the discription of children's ideas to be validated against teachers' experiences and, often subconscious, knowledge of children's views, and secondly to provide a focus for action-research. Currently these groups of practicing teachers are discussing the information contained within particular working papers, and discussing the implications for teacher training, curriculum development and specific lesson plans.

In addition to the work described above, we are most concerned that our results can be communicated to teachers on a much wider front. Thus we have developed three forms of a Workshop (focussing on 'force', 'particulate matter', and 'living' respectively) which run for half a day and which can accommodate primary, secondary and tertiary teachers simultaneously. (Gilbert, Osborne (1980b)). This Workshop has been used both in New Zealand and the United Kingdom.

Future research

As regards research, work is under way to:

(a) study children's egocentric views of the world through their own scientific conceptions.

(b) consider how their views change, and at what point in the child's development this happens.

(c) investigate the retention of intuitive ideas despite formal teaching.

(d) examine the language of students in discussing scientific concepts, and consider how this reflects their understanding.

(e) consider how attitudes and orientation towards science can help in the development of concepts.

(f) consider how learning style might affect the development of concepts.

(g) study the relationship between concepts, the 'alternative framework' developed by the child.

(h) to investigate any sex and cultural differences in concept development.

(i) to investigate the broader implication of these results for teaching (Gilbert, Osborne, Fensham (in press)).

(j) to explore the diagnostic value of the technique in the hands of teachers and self monitoring value when in the hands of students.

DOCUMENTS

LISP (1980). Working papers of the Learning in Science Project, No. 15-26, University of Waikato, S.E.R.U.

Watts,D.M. (1980a). A transcription format. Mimeograph. University of Surrey, I.E.T.

Watts, D.M. (1980b). Exploration of the concept of 'Force', Mimeograph. University of Surrey, I.E.T.

Watts, D.M. (1980c). Suggestions for generating and designing cards for the Interview-about-Instances approach. Mimeograph. University of Surrey, I.E.T.

Zylbersztajn, A. (1980). Transformations of knowledge in a curricular context : the outline of a study. University of Surrey, I.E.T.

Zylbersztajn, A. (1981). The Analysis of one lesson. University of Surrey, I.E.T.

Zylbersztajn, A., Watts, D.M. (1980). Surveying some ideas about force. Mimeograph. University of Surrey, I.E.T.

REFERENCES

Archenhold, W.F. (1980). An empirical study of the understanding by 16 - 19 year old students of the concepts of work and potential in physics. in Archenhold, W. (et al) (eds) , Cognitive Development Research in Science and Maths. University of Leeds : Centre for Studies in Science Education.

Ausubel, D.P. (1968) Educational Psychology : A Cognitive View. New York. Holt, Rinehart, Winston.

Driver, R, Easley, J. (1978). Pupils and paradigms: a review of literature related to concept development in adolescent science students Studies in Science Education, 5, p 61-84.

Gilbert, J.K., Osborne, R.J. (1980a) 'I understand, but I don't get it' : some problems of learning science. School Science Review, 61, p.664-73.

Gilbert, J.K., Osborne, R.J. (1980b) From children's science to scientist's science : a workshop (physics) (chemistry) (biology) University of Surrey, I.E.T. 85 pages.

Gilbert, J.K., Osborne, R.J. Fensham, P.J.
Children's science and its consequences for teaching.
Submitted to Sci.Educ.

Helm, H (1980) Misconceptions in physics amongst South African students. Phy. Educ. 15, p. 92 - 105.

Lachenmeyer, C. (1971) The language of sociology. Columbia Univ. Press.

Osborne, R.J. (1980) Some aspects of the students' view of the world. Research in Science Education, 10, (in press).

Osborne, R.J., Gilbert, J.K. (1980) A technique for exploring students' views of the world. Phy. Educ., 15 p.376-9.

Pines, A.L. (1980) Protocols as indications of cognitive structure: a cautionary note. J.R.S.T., 17 (4) p.361-2.

Quine, W. (1960). Word and Object. M.I.T. Press.

Tasker, C.R. (1980). Some aspects of the students' view of doing science. Research in Science Education, 10, (in press).

Tiberghien, A. (1980). Modes and conditions of learning in Archenhold, F. (et al) (eds). Cognitive Development Research in Science and Mathematics. Leeds : Centre for Studies in Science Education. p. 288-309.

Viennot, L. (1979) Spontaneous reasoning in elementary dynamics. Eur. J. Sci. Educ. 1 (2) p. 205-21.

Warren, J.W. (1979) Understanding Force. London. John Murray.

West, L.T.H. (1980). Toward descriptions of the cognitive structures of science students, in Archenhald, W.F. (et.al)(eds) Cognitive Development Research in Science and Maths, University of Leeds : Centre for Studies in Science Education.

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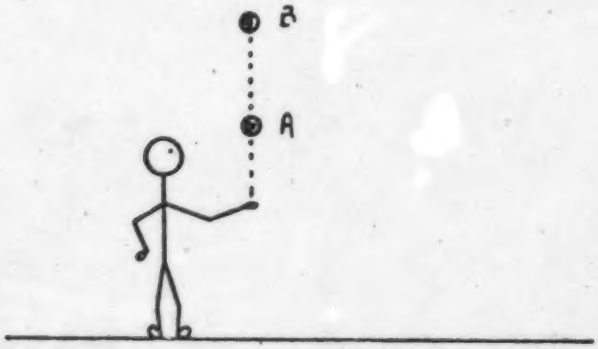


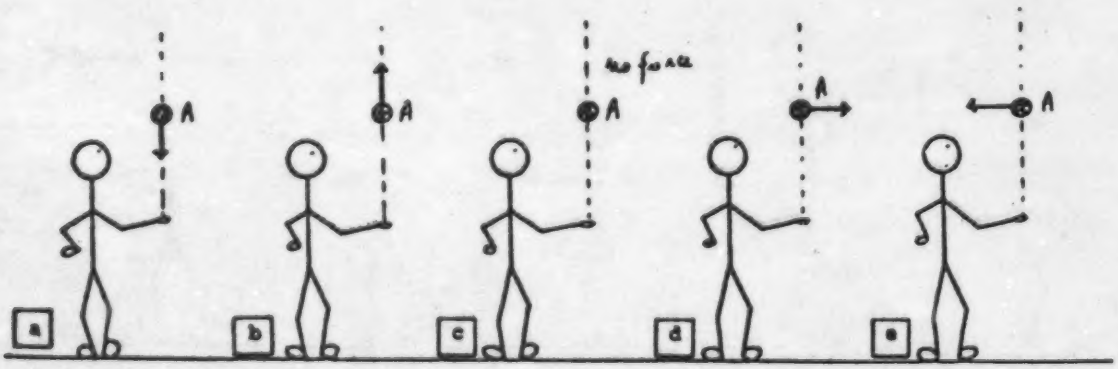
A stone is thrown straight up in the air.

It leaves the person's hand, goes up through point A, gets as high as B and then comes back down through A again.

The following three cards refer to this situation.

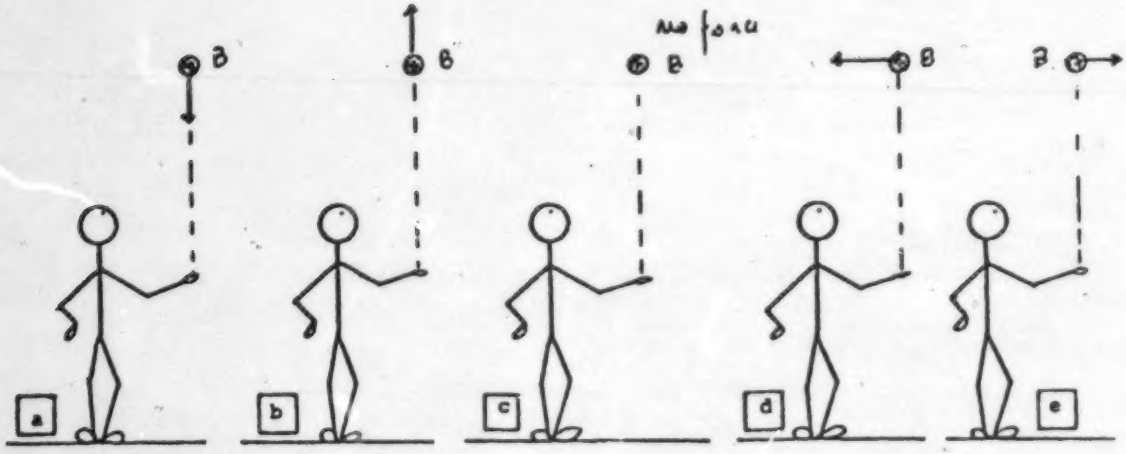
The arrows in the pictures are supposed to show the direction of the force on the the stone.

1. Which picture do you think best shows the force on the stone on its way up through A ?



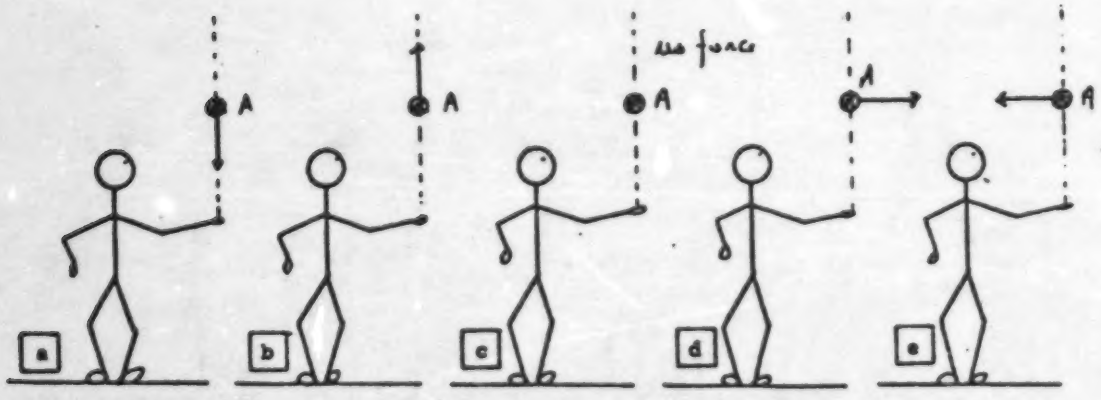
Explanation:

2. Now, which pictures do you think best shows the force on the stone when it <u>reaches</u> the point B (Maximum height)?



Explanation:

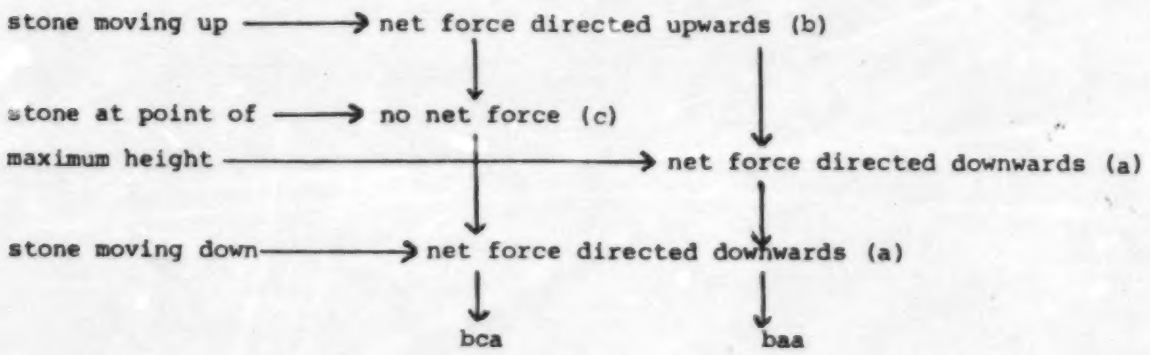
3. Now, which picture do you think best shows the force on the stone when it is passing through the point A on <u>its way down</u> ?



Explanation:

RESPONSE PATTERN	% RESPONSE PATTERNS FOR STUDENT AGE GROUP				
	13 - 14	14 - 15	15 - 16	16 - 17	17 - 18
	(N=254)	(N=195)	(N=174)	(N=147)	(N=75)
bca	46	53	66	53	52
bba	4	1	1	-	-
baa	14	11	9	4	1
aca	9	5	5	14	21
aaa	5	11	6	22	19
acb	11	10	10	7	7
(other)	11	9	3	-	-

The two most commonly found patterns (bca, baa), amongst 13 - 14 year old children, are presented below.



This result confirms impressions gained from the analysis of transcript data.

APPENDIX B: An extract from a LISP Working Paper (No.20, Gravity)

As might be expected from the last subsection, students could be found who held the belief that there was no gravity at all on the moon.

"It's only on earth as much as we know and it's not on the moon, or anywhere like that". (11 year old, boy; also 2 x 11 year olds)

"So, if there's no air up on the moon, that means that there won't be much gravity". (12 year old, boy)

"Oh, there's gravity on other planets; there's probably gravity on nearly every planet in the galaxy, or universe. While not every planet does have gravity, like the moon". (14 year old, boy)

"Well, the moon's got no gravity and you float off - and out in space, you just float around". (12 year old, boy)

A survey question was used to investigate the prevalence of this view.

Standing on the moon

Look at the picture. Is there any gravity?

(a) Yes, but much more than on the earth
(b) Yes, about the same as on the earth
(c) Yes, but much less than on the earth
(d) No, there is no gravity.

Results as percentages: (scientific viewpoint underlined)

	13 yr old (N = 258)	14 yr old (N = 201)	15 yr old (N = 179)	16 yr old (N = 145)	17 yr old (N = 75)
a	12	7	3	-	-
b	2	3	1	1	-
c	42	67	70	96	96
d	44	24	26	4	4

NOTE: 13-15 year olds were studying science, 16 & 17 year olds were studying Physics.